Statement of

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Before the

House Committee on Transportation and Infrastructure

Climate Change and Energy Independence:
Transportation and Infrastructure Issues

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Mr. Chairman, Members of the Committee. Good morning and thank you for inviting me to address the Committee and provide GE's perspective on climate change and energy independence. Today, my testimony will focus on some innovative technologies that are beneficial both for reducing generation of greenhouse gases and increasing our energy independence.

I am Ed Hall, Executive Leader of Engine Engineering for GE Transportation. In this role, I am responsible for, among other things, all phases of diesel-fueled engine development. GE Transportation is the world's leading manufacturer of diesel-electric locomotives with more than 15,000 locomotives operating around the globe. At the same time, we're a significant provider of on-board and wayside signaling, communications, control and information systems. We're also the industry leader in service, maintaining an installed base of more than 8,000 locomotives worldwide. Our customers include major and shortline freight railroads, passenger lines and urban transport systems around the world.

GE Transportation's history of innovation dates back to the late 1800s, when Thomas Edison invented an electric locomotive that helped launch the GE Company. We built our first diesel engines for rail nearly 90 years ago, and today we remain at the forefront of technology advancements in the rail transportation industry.

GE has more than 28,000 technologists across the company and around the world representing virtually every scientific discipline. Our mission today is the same as it was at the time of our founding in 1900 -- to drive innovations that create new or better GE products and meet the needs of our customers and of society. From developing the first U.S. jet engine to developing many of the technologies that helped build today's modern electrical grid, GE has a proven record of moving the state of technology forward in a meaningful and practical way. Our breakthroughs have had real impact not only in transforming the nation's infrastructure, but also in improving people's lives.

We gather at a time when concerns about energy security and global climate change are at the top of everyone's list. In May 2005, GE launched ecomagination. Ecomagination represents the company's commitment to develop cleaner, more efficient and environmentally friendly products. As part of this initiative, we have pledged to double our level of R&D investment in green technologies from $700 million to more than $1.5 billion by the year 2010.

Since launching ecomagination, we already have more than doubled the number of green products from the 17 that had originally been identified. GE's customers and consumers now have more and better choices to reduce their emissions and energy consumption. In the years ahead, we will introduce even more products to help address the challenges of global climate change. GE Aviation's GEnx aircraft engine will deliver 15% better fuel efficiency than the engines it will replace. The number of these engines projected to be sold in the next 20 years will emit an estimated 77 million fewer tons of greenhouse gases than would have been produced by older comparable engines. If today's fleet of 200-300 passenger aircraft had GEnx engines, annual carbon dioxide emissions would be reduced by an amount equal to removing more than 800,000 cars from the road for a year or adding more than 1.2 million acres of forest. And, by using

GEnx engines, that same fleet could save nearly 500 million gallons of jet fuel annually.

In February of this year, GE's Vice Chairman, and President and CEO for GE Infrastructure, John Rice, testified before the Subcommittee on Energy & Power, Energy & Commerce Committee in the U.S. House of Representatives, and called for enactment of U. S. legislation on climate change at the earliest date possible. He further stated that science has reached a point where such legislation is possible. Indeed, if Congress enacted climate change legislation today, the technology exists to support viable options for the regulated community. We have technologies available that can reduce greenhouse gas emissions, including the rail sector. Also, on these topics and just a week ago, Mark Little, GE's Senior Vice President and Director of Global Research, testified before the Senate Subcommittee on Private Sector and Consumer Solutions to Global Warming and Wildlife Protection highlighting many technologies that GE has developed and is developing to address climate change.

Today, my testimony will focus on two technologies that are being introduced right now for locomotives – hybrid technology and what we call "trip optimizer." In discussing these technologies, it's important to understand that success in providing readily available solutions in terms of climate change is directly tied to government setting a clear, consistent policy direction and continuing its strong commitment with industry and academia to aggressively invest in and accelerate the advancement of clean energy technology. That means that regulatory agencies need to value and promote development of these technologies and to ensure that existing and future regulations are written flexibly to complement, not hinder, their introduction and deployment. We have already seen how government policies can positively impact the growth and availability of

clean energy solutions, and we hope that future policies and regulations will do the same.[1]

The first technology I would like to discuss is the hybrid locomotive, which we will be demonstrating for the first time later this month at a planned *GE ecomagination* event in California. We are all familiar with hybrids in the automotive context, but let me explain how it works for locomotives. All hybrid vehicles use some form of energy storage to recover energy that would otherwise be wasted. The difference between a car and a train, however, is that while a hybrid car can recover and store energy from a single vehicle, a hybrid locomotive has the potential to capture and store the energy from the hundreds of cars and thousands of tons of freight being pulled. It is therefore easy to imagine that a single hybrid locomotive could exceed the energy savings impact of hundreds of automobiles.

Locomotives, like non-hybrid cars, use brakes to dissipate the energy of the moving vehicle by converting this energy to heat and venting that heat to the atmosphere. GE's Evolution Hybrid is a modified version of our Evolution locomotive that has the ability to store some of the energy generated during braking in a series of specially designed lead-free batteries. The Evolution Hybrid utilizes the existing drive motors to convert this braking energy into electrical energy that is stored in the battery system. When needed, the batteries supply the locomotive with extra power that can then be used to reduce fuel consumption and reduce emissions.

So now, when the locomotive is traveling downhill, making sharp turns, or slowing down for speed limits, the energy generated by braking will be stored in the battery – that power won't go to waste. This reduces the total power that

[1] For example, the enactment of the federal Production Tax Credit and the new Renewable Portfolio Standards in more than 20 states have helped to fuel a three-fold expansion of the wind industry in the U.S. over the past few years. In Europe where policies have been more consistently applied, the growth has been more rapid and substantial.

needs to be generated by the diesel-electric engine, saving on total fuel burn and emissions. The Evolution Hybrid can even use the batteries as the primary source of power to reduce emissions in restrictive zones.

In terms of carbon reduction, the Evolution Hybrid has the ability to reduce fuel consumption by 10% when compared to a today's Evolution. Using 10% less fuel directly reduces the emissions of carbon dioxide, NOx, and particulate by 10%. If Hybrid technology replaced 100 Tier 1 locomotives in service,[2] over the next 10 years it would save over 510,000 tons of carbon dioxide from being produced every year. This is equivalent to removing 89,000 cars annually or 890,000 over 10 years from our roads.

In terms of potential energy savings, if the Evolution Hybrid replaced 100 Tier 1 locomotives in service, it would save more than 45 million gallons of fuel over the next 10 years.

We are excited about this new innovative technology and are confident it will continue to develop and improve as we gain experience in the field.

The second technology I would like to discuss today is called "Trip Optimizer." Trip Optimizer is a locomotive control system "enhancement" that manages the speed and throttle settings to minimize fuel consumption, taking into account train composition, terrain, track conditions, train dynamics and weather, without negatively impacting the train's arrival time. Put simply, Trip Optimizer uses global position systems or "GPS" and forward-looking terrain mapping to plan a locomotive's trip, and it develops a recipe to minimize fuel usage and meet speed limits along the way. The "recipe" is constantly updated and gives the onboard crew a tool to manage the journey in a completely novel way, by allowing explicit trades between journey completion time and the fuel

[2] It is expected that hybrid sales will capture approximately 10% of the annual locomotive market. This will lead to the retirement of existing engines that will be meeting the current Tier 1 emissions standards.

used, as opposed to operating at or near the speed limit all the time. In principle, Trip Optimizer could be applied to any engine and achieve a 10% fuel savings and a 10% reduction in carbon dioxide, NOx, and particulate emissions. To give you a sense of the large potential benefits of this technology, applying Trip Optimizer to a single GE Evolution locomotive could save 360 tons per year of carbon dioxide emissions and 32,000 gallons of fuel annually. If this technology is installed on 1,000 Tier 2 GE Evolution locomotives in a given year, we have the possibility of 360,000 fewer tons of carbon dioxide emitted.

These two technologies show that there are innovative solutions for our transportation systems that can achieve both a reduction in all emissions *and* a net fuel savings benefit.

As this Committee considers climate change and energy independence, GE believes that it is critical that government policies

- encourage innovations that save on fuel and reduce emissions overall – taking into account traditional pollutants and carbon dioxide;
- at a minimum, provide incentives to railroads that adopt such technologies; and
- ensure that existing and future policies do not present obstacles to their introduction; on the contrary, policies should promote their development.

GE believes several technologies can be readily deployed today in the short-term and that there are even more new and exciting technologies on the horizon. The success of these technologies depends upon having the right policies in place and a committed partner in government to help accelerate needed advancements.

Mr. Chairman, I want to thank you and members of the Committee for the opportunity to provide testimony. Addressing the issues of climate change and energy independence is a tremendous challenge both for our nation and the

world. GE is providing now – and developing for the future – technologies that will help to meet that challenge.

Thank you.

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Ed is a three-time Mechanical Engineering graduate of Iowa State University (B.S. '81, M.S. '83, Ph D. '89). Ed began his professional career with the Allison Gas Turbine Division of General Motors. Ed was awarded a General Motors Fellowship in 1985 enabling his doctoral studies. Upon returning to Allison, Ed participated in a series of NASA-funded advanced gas turbine programs where he developed the industry-leading ADPAC code for predicting performance in multistage compressors and turbines. Later, Ed led the aero/thermal design/analysis team at Allison that focused on aerodynamics, heat transfer, acoustics and dynamics of advanced gas turbine engines. Ed contributed to several production engine designs including the AE3007 regional jet engine now in service with Continental and American Airlines, the Joint Strike Fighter LiftFan vertical takeoff and land military aircraft, and the AE2100 turboprop engine that provides power for the C130J military transport aircraft. Ed also led the Leadership Training Initiative for Rolls-Royce following their acquisition of Allison.

Ed joined GE in 2002 at their Global Research Center in Niskayuna, NY. Ed led the Fluid Mechanics Lab in developing aerodynamic technologies for aircraft and stationary power gas turbine engines as well as wind turbines, steam turbines and other fluid power devices. In 2003 Ed was named Global Technology Leader for the Physical Sciences organization within GE. This team employed a combination of advanced physics and mechanical technologies leading to new products for several GE businesses including Healthcare, Plastics, Energy, Transportation and Aviation.

In 2006, Ed joined the GE Transportation business as executive leader of the Engine Engineering organization. His responsibilities include all phases of diesel fueled engine development for GE Transportation as well as gas-fueled engines for the GE Jenbacher business.